



## RESEARCH ARTICLE

### ASSOCIATION OF THE ALVARADO CRITERIA WITH TOMOGRAPHIC FINDINGS FOR THE DIAGNOSIS OF ACUTE APPENDICITIS IN PATIENTS WITH ABDOMINAL PAIN ATTENDED AT THE EMERGENCY DEPARTMENT

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#### ABSTRACT

**Background:** In acute appendicitis, abdominal computerized tomography (abdominal CT) has increased diagnostic certainty. The clinical criteria of Alvarado show some utility in the diagnosis of acute appendicitis.

**Objective:** To determine the correlation between the Alvarado Clinical Scale and the radiological finding by abdominal CT in relation to the diagnosis of acute appendicitis in patients with acute abdominal pain.

**Material and methods:** We included 62 patients with suspected acute appendicitis treated in the emergency room. The criteria of the Alvarado Scale were related to the abdominal CT findings of the abdomen.

**Results:** Seventy-one percent (n = 43) of patients diagnosed with appendicitis in relation to abdominal CT findings and in agreement with the Alvarado Scale showed an average risk (4-6 points). The results adjusted to the Alvarado Scale score at 5 points as upper and lower limit to form two groups, 77% (n = 47) of patients with appendicitis diagnosed in relation to Tomographic findings and in agreement with the Alvarado Scale showed a high risk (> 5 points). The coefficient of contiguity V of Cramer was 0.32 (p < 0.05).

**Conclusion:** We found a low coefficient of correlation between Alvarado's criteria and abdominal CT.

#### INTRODUCTION

Acute appendicitis is one of the main causes of abdominal pain in the emergency department that requires surgical treatment, occurs at any stage of life (Owen *et al.*, 1992 and Alexander *et al.*, 2007). The risk of presenting acute appendicitis throughout life is estimated at approximately 7% in the general population (Guss *et al.*, 2008). The incidence is 11 cases per 10,000 a year. An adequate clinical history in combination with the clinical findings of localized peritonitis is usually sufficient to make the diagnosis of acute appendicitis (McKay *et al.*, 2007, Frei *et al.*, 2008, Ives *et al.*, 2008). However, diagnosis is not always simple, especially in female patients with gynecological pathology who can simulate acute appendicitis (Mazeh *et al.*, 2009, Pouget-Baudry *et al.*, 2010). Variability in the anatomical position of the appendix and retrocecal or retroileal location may not allow patients to present sufficient peritoneal signs to support the diagnosis of acute appendicitis (Horn *et al.*, 2011).

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Several diagnostic scales have been proposed and created for acute appendicitis, the Alvarado clinimetric scale being the best known and the most used, since its use has been validated in multiple studies (Wang *et al.*, 2012). To date, a reliable marker of acute appendicitis has not yet been identified, despite advances in technology and research modalities, the rate of negative appendectomies remains between 15% and 50% (Petroianu 2012, Bröker *et al.*, 2012). A negative abdominal ultrasound (USG) study is not adequate to rule out appendicitis, so it should always be followed by a simple abdominal tomography. Research studies show that there is some benefit to perform a CT scan in patients presenting abdominal pain with clinical data few suggestive of acute appendicitis, especially in women to identify inflammatory pathologies of the adnexal type, and the criteria used in the Alvarado Scale (Shaligram *et al.*, 2012, Meltzer *et al.*, 2013). Most often occurs in late stages of appendicitis, with the risk of perforation and sepsis. Our aim was to determine the correlation between the Alvarado Clinical Scale and the radiological finding by abdominal tomography in relation to

the diagnosis of acute appendicitis in patients with acute abdominal pain.

**MATERIAL AND METHODS**

We included 62 files of patients with suspected acute appendicitis treated in the emergency department. The criteria of the Alvarado Scale were recorded and related to the tomographic findings of the abdomen.

**Statistical analysis**

Contingency tables were used for the dependent and independent variables where the Chi square test was applied with a level of significance lower than 0.05. The coefficient of contingency or agreement of Cramer between the variables of interest was obtained considering a level of significance or of correlation of 0.3. We analyzed all the variables with normality tests for the qualitative and quantitative variables using the Kolmogorov-Smirnov and Shapiro-Wills statistic, respectively. Means and standard deviations were determined for the quantitative variables. Absolute and relative frequencies were used for the qualitative variables. Contingency tables were used for the dependent and independent variables where the Chi square test was applied with a level of significance lower than 0.05. The coefficient of contingency or concordance of Cramer's V was obtained between the variables of interest considering a level of significance or correlation of 0.3. All data were analyzed using the SPSS program (IBM version 23).

**Ethical approval**

The protocol was reviewed and approved by the Ethics and Research Committee of the Navy General Hospital High Specialty., office number 2S.1.1014 / JP467 / 16.

**RESULTS**

A total of 148 clinical files of patients with acute abdominal pain attended at the General Hospital Naval de Alta Especialidad were studied in a 3-year period (2013, n = 29, 2014, n = 48, 2015 n = 71) (Figure 1). Of these 148, only 62 patients were operated on for acute appendicitis diagnosis, 37 were female, 25 were male, the mean age was 34.5 years in a range of 15 to 80 years (Table 1), they had an abdominal computerized tomography (abdominal CT) taken because patients have abdominal pain probable secondary to acute appendicitis. The Alvarado Scale was positive ( $\geq 7$ ) in 23% (n = 14) of the patients. The sensitivity of the Alvarado Scale to detect patients with acute appendicitis was 22.95%. The abdominal tomographic study was performed in 61 patients, 9% (n = 5); The most frequent finding was appendicular wall thickening and changes in periappendicular fat with a relative frequency of 57% (n = 35) (Table 2, Figure 2). The sensitivity of the tomographic findings to detect patients with acute appendicitis was 91.8%.

Table 3 shows that 21% (n=13 ) of patients with a diagnosis of appendicitis in relation to the tomographic findings and in agreement with the Alvarado Scale showed a high risk (4-6 points). The coefficient of contiguity V of Cramer was 0.02 (p <0.05), not evidencing a significance of correlation between both tests for the diagnosis of acute appendicitis. In Table 4, with the results adjusted to the Alvarado Scale score at 5 points as upper and lower limit to form two groups, 77% (n = 47) of patients with appendicitis diagnosed in relation to Tomographic findings and in agreement with the Alvarado Scale showed a high risk (> 5 points). The coefficient of contiguity V of Cramer was 0.32 (p <0.05), evidencing a significance of correlation between both tests for the diagnosis of acute appendicitis.

**Table 1. General characteristics of patients with acute appendicitis related to sex**

	Mujeres N=37 (61 %)	Hombres N=24 (39 %)	P
Age (years)	34.3 ± 14.8	37.4 ± 13.8	0.22
Age intervals			0.53
	15 a 39 años	30 (81 %)	17 (71 %)
	40 a 65 años	4 (11 %)	6 (25 %)
	>65 años	3 (8 %)	1 (4 %)

**Table 2. Patients with a presumptive diagnosis of acute appendicitis in relation to the Abdominal CT findings**

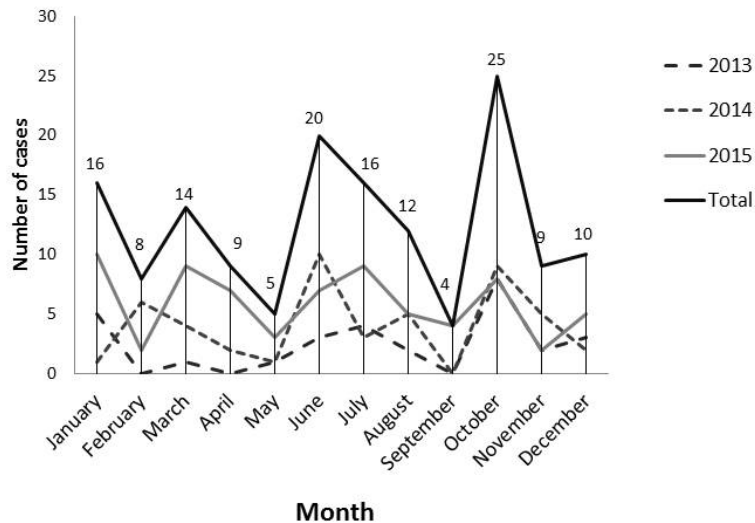
	Frequency
Thickening of the appendicular wall	5 (8 %)
Thickening of the appendicular wall + Dilation of appendicular light	9 (15 %)
Thickening of the appendicular wall + Periappendicular fat changes	35 (57 %)
Thickening of the appendicular wall + Dilation of appendicular light + Periappendicular fat changes	7 (11 %)
Report without acute appendicitis	5 (9 %)

**Table 3. Association of the Alvarado criteria score and the abdominal CT findings observed in patients with appendicitis**

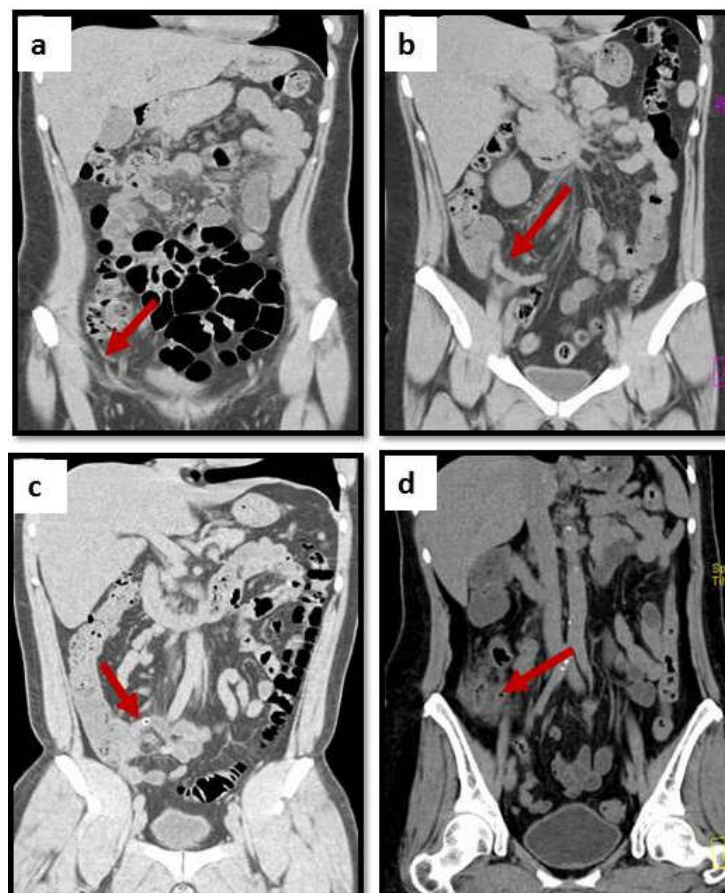
V de Cramer=0.02, p=0.03	Alvarado criteria		Total
	Middle Risk (4-6 points)	High Risk (7-10 points)	
Acute appendicitis diagnosis by Abdominal CT	43 (71 %)	13 (21 %)	56(92%)
Non diagnosis of Acute appendicitis by Abdominal CT	4 (7 %)	1 (1 %)	5 (8 %)
Total	47 (78 %)	14 (22 %)	61(100%)

**Table 4. Association of the Alvarado criteria score and the abdominal CT findings observed in patients with appendicitis adjusted to a cutoff point**

V de Cramer=0.32, p=0.03	Alvarado criteria		Total
	Middle Risk (< 5 points)	High Risk (> 5 points)	
Acute appendicitis diagnosis by Abdominal CT	9 (15 %)	47 (77%)	56 (92%)
Non diagnosis of Acute appendicitis by Abdominal CT	4 (7 %)	1 (1 %)	5 (8%)
Total	13 (78%)	48 (22 %)	61(100%)



**Figure 1. Prevalence of acute abdominal pain treated in the emergency room of the Hospital General Naval High Specialty**



**Figure 2. Tomographic findings of appendicitis a) Abdominal CT in a coronal section with a normal appendiceal image, b) Abdominal CT in a coronal section showing enlargement of the appendiceal wall and dilation of the appendiceal lumen, c) Abdominal CT in a coronal section showing appendiceal dilatation and changes in peri appendiceal fat, d) Abdominal CT in a coronal section showing thickening, dilatation, and changes in peri appendiceal fat**

## DISCUSSION

Acute appendicitis remains the most common abdominal pathology requiring emergency surgery (Memon *et al.*, 2013). Epidemiological studies have shown that appendicitis is more common in patients younger than 15 years of age. In our study, the mean age was 35.6 years, similar to that reported by Andrew *et al.*, with a predominance of females (Wray *et al.*, 2013). For more than 100 years, the diagnosis of acute appendicitis has been based on medical history, physical examination and, to a lesser extent, laboratory results (Nelson *et al.*, 2013). For experienced physicians, an accurate diagnosis is simple in most cases, however, an unsatisfactory diagnosis persists (Teixeira *et al.*, 2013). There are numerous tools that can be used in the evaluation of patients with suspected appendicitis. However, these tools are used in practice largely depending on the availability of resources from each hospital (Aranda *et al.*, 2013, McCutcheon *et al.*, 2014). The main clinical manifestation of appendicitis is abdominal pain located in the right iliac fossa, provided that this is a typical case. In this study, 50 patients reported onset of pain in the epigastrium, subsequent migration to the right iliac fossa (Tan *et al.*, 2015); In 12 cases there was atypical presentation, in which the diagnosis was difficult, becoming more relevant in the reproductive stage of the female sex due to the multiple pathologies of gynecological origin that can similar an appendicular picture (Apisarnthanarak *et al.*, 2015, Pham *et al.*, 2015). The Alvarado Scale is one of the Clinimetric tools that proposes to stratify patients' risk by their probability of having acute appendicitis. It uses a maximum score of 10 points, where those patients greater than 7 points are at high risk of presenting a picture of acute appendicitis.

The consensus is that the Alvarado score is a noninvasive, safe, diagnostic method that is simple, reliable and repeatable, and capable of guiding the clinician in the management of the case of appendicitis (Al- Abed *et al.*, 2015, Ekere *et al.*, 2013). However, a recent study showed a sensitivity of only 72% for the detection of acute appendicitis. In our study we reported a sensitivity of 22.95% which has led to criticism of the usefulness of the score for our population. Since the 1990s, researchers began to publish the results of studies in which abdominal tomography was used in the evaluation of suspected appendicitis. In Boston focused their investigations specifically on the reduction of negative appendectomy due to the high sensitivity that this diagnostic method has shown (Wray *et al.*, 2013). The sensitivity reported by these authors was 91%, while that reported by our study was 92%. The use of simple abdominal tomography has allowed the reduction of negative appendectomies. In our study we evaluated the Clinical Association of the Alvarado Scale as a screening tool to determine which patients might be candidates for performing an abdominal tomography to confirm the diagnosis of acute appendicitis. The purpose is not to submit patients of low diagnostic risk to an extension study with risk of radiation and institutional costs in its implementation; Are independent diagnostic support methods, if there is no tomograph. The Alvarado criteria will be used. If you have the tomography resource to use it, because of the greater sensitivity and specificity. In the results obtained and compared, in relation to the current risk staging for the Alvarado Scale and the tomographic findings observed, we showed that there is no correlation between the two tests for the diagnosis of acute appendicitis in those patients with medium and low risk.

Performing the adjustment of the Alvarado Scale with a 5-point cut-off point best predicts a correlation coefficient for both tests being significant. This last observation allows us to adjust the diagnostic algorithm for those patients who are at a level greater than 5 points to undergo an abdominal tomographic study.

## Conclusion

Abdominal CT has a greater sensitivity for the diagnosis of acute appendicitis compared to the clinical score of the Alvarado Scale. They have no association between them when presenting different cut-off points to determine the probability of diagnosis because they are independent tests. Our study provides supporting evidence for the inclusion of abdominal tomography in the clinical evaluation of acute appendicitis in those patients with a score level greater than 5 on the Alvarado Scale. The use of multimodal approaches (Alvarado Scale score and abdominal tomography) will help physicians select patients suitable for a surgical treatment.

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